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532 Rec'd PCT/PTC 27 SEP 2000

UNITED STATES PATENT APPLICATION TRANSMITTAL FORM

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Docket No.: 976.0089USU

Sir:

Transmitted herewith for filing is the patent application of

Applicant (s): William Sharpe
For: SIMILARITY SEARCHING FOR DOCUMENTS
International Application No.: PCT/GB00/00489
International Filing Date: 15 February 2000

ENTERING OF U.S. NATIONAL STAGE UNDER 35 U.S.C. §371

Transmitted herewith for filing are the following documents submitted under 37 C.F.R. §1.495(b) for the purpose of entering the national stage in the United States of America as an elected office. Enclosed are:

- XXXX Specification and Claims with Declaration;
- Specification and Claims *without* Declaration;
- XXXX 4 sheets of drawings;
- XXXX Preliminary Amendment;
- XXXX An Assignment of the invention to: Hewlett-Packard Company, including \$40.00 recordation fee;
- The certified copy of a priority application;
- XXXX Information Disclosure Statement with copies of patent(s) (Form - PTO-1449);
- Verified Statement of Small Entity (Independent Inventor);
- Verified Statement of Small Entity (Small Business Concern);

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XXXX Priority of application Serial No. 9903451.4, filed on 16 February 1999 in Great Britain; and PCT International Application No. PCT/GB00/00489 filed on 15 February 2000 is claimed under 35 U.S.C. §119 and 35 U.S.C. §365;

____ Cover page of published PCT Publication No. _____;

____ Copy of International Preliminary Examination dated 01 December 1999;

____ Copy of PCT Demand Under Article 31; and

XXXX Copy of International Search Report dated 03 July 2000.

____ Copy of Written Opinion.

____ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) are transmitted herewith.

The Filing Fee is calculated below.

| CLAIMS AS FILED | | | | |
|--|---------------------|---------------------|-------------|---|
| (1) For | (2) Number Filed | (3) Number Extra | (4) Rate | (5) Basic Fee \$670/\$760// \$840/ \$970/\$96 |
| Total Claims | 17 - 20 = | 0 | x \$18.00 | \$0 |
| Independent Claims | 2 - 3 = | 0 | x \$78.00 | \$0 |
| Multiple Dependent Claim Fee | | | | x \$260.00 = \$0.00 |
| TOTAL FILING FEE | | | | \$840.00 |
| 1/2 FILING FEE FOR SMALL ENTITY | | | | \$0 |

XXXX Firm's check in the amount of \$ 880.00 to cover the filing fee (\$840) and Assignment recordal fee (\$40);

XXXX The Commissioner is hereby authorized to charge any additional fees under 37 C.F.R. 1.16 and 1.17 which may be required with this communication or during the entire pendency of the application, or credit any overpayment, to **Deposit Account No. 01-0467**. A duplicate copy of this Form is enclosed.

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(Typed name of person mailing paper)

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(Signature of person mailing paper)

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526 Rec'd U.S.P.T.O.

27 SEP 2000

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: Sharpe, William et al.

SERIAL No. Unassigned

EXAMINER: Unassigned

FILED: Herewith

GROUP NO.: Unassigned

TITLE: SIMILARITY SEARCHING FOR DOCUMENTS

Attorney Docket No.: 30990053US

Assistant Commissioner For Patents
Washington, D.C. 20231

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Paul D. Greeley

Name

Paul D. Greeley

Signature

PRELIMINARY AMENDMENT TO ACCOMPANY NATIONAL STAGE FILING

UNDER 35 U.S.C 371

Dear Sir:

Please amend the application filed herewith as follows:

In The Claims

All of the claims, whether amended or not, are shown below for the convenience of the Examiner.

1. A method of searching a database to find documents similar to a query document, comprising:

decomposing the query document into elements of different data types;

for one or more of the elements in a first data type, conducting a first data type similarity search to return match results from the database for the one or more elements in the first data type;

for one or more of the elements in a second data type, conducting a second data type similarity search to return match results from the database for the one or more elements in the first data type;

combining the match results from the first data type similarity search and the second data type similarity search to provide query document match results.

2. A method as claimed in claim 1, wherein one of the data types is representative of text.
3. A method as claimed in claim 2, wherein a plurality of the data types are representative of text, separate data types of the plurality being representative of different functional blocks of text.
4. (Amended) A method as claimed in [any preceding claim] claim 1, wherein one of the data types is representative of pictorial images.
5. (Amended) A method as claimed in [any preceding claim] claim 1, wherein one of the data types is representative of graphical images.
6. (Amended) A method as claimed in [any preceding claim] claim 1, wherein one of the data types is representative of the arrangement of other data types within the document.
7. (Amended) A method as claimed in [any preceding claim] claim 1, wherein the step of similarity searching to return match results is carried out, separately, for a plurality of elements having between them more than two data types.
8. (Amended) A method as claimed in [any preceding claim] claim 1, where all features of a common data type in the document are treated as one element.
9. (Amended) A method as claimed in [any of] claim[s] 1 [to 7], where spatially distinct features of a common data type in the document are treated as separate elements.
10. (Amended) A method as claimed in [any preceding claim] claim 1,

wherein elements are user selectable or deselectable for the step of similarity searching.

11. (Amended) A method as claimed in [any preceding claim] claim 1, wherein the similarity searching results for separate elements are weighted before combination.

12. A method as claimed in claim 11, wherein said weighting is user selected.

13. A method as claimed in claim 11, wherein said weighting is attributed according to a determined significance of each relevant element in the document.

14. (Amended) A method of searching a database to find documents similar to a query document, comprising:

decomposing the query document into elements of different data types;

determining a layout element in a layout datatype from the spatial arrangement of the elements in the document; and

for the layout element, conducting a layout similarity search to return match results from the database for the layout element.

15. A method as claimed in claim 14, wherein the layout similarity search involves searching against templates representative of different document types.

16. A method as claimed in claim 14, wherein the elements include elements of separate data types representative of different functional blocks of text.

17. (Amended) A method as claimed in claim 14 [or claim 16], wherein the elements include elements of data types representative of images.

REMARKS

This preliminary amendment is submitted with an application being submitted under 35 U.S.C. 371, as part of the National Phase filing of International Patent Application PCT/GB00/00489. Claims 1-17 remain in the application.

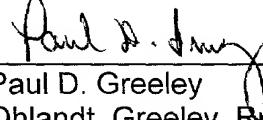
Claims 4-11 and 17 have been amended to eliminate any multiple dependencies, and claim 14 has been amended to correct a typographical error.

Consideration and allowance of the claims is respectfully requested.

Respectfully submitted,

9-27-00

Date



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SIMILARITY SEARCHING FOR DOCUMENTS

Field of Invention

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The present invention relates to a method and means for searching to find similar documents in response to a query. The invention is particularly relevant to the use of one document as a query for a search to obtain similar documents.

10 Description of Prior Art

Similarity searching in databases of electronically stored documents is an important area of practical application. Such searching is well known for text. Typically, the input for such searching would be a text string, and the engine would then search the database matching entries against the text string and return entries with an acceptable similarity threshold. Similar searching is available for images - an example is the IBM Corporation QBIC (Query by Image Content) package, described at and available from <http://www.qbic.almaden.ibm.com/>.

15 Research has also been done on using structural analysis of a document in searching, particularly at the German Research Center for Artificial Intelligence GmbH (DFKI) in systems such as Office Maid and SALT. These systems are further described at <http://www.dFKI.uni-kl.de>.

20 Existing techniques are effective when the query is of essentially one data type: a text string only, or an image only. In general, however, an electronic document will consist of a combination a number of data types: a typical document might contain one or more text passages, one or more images, and line art. The text passages may also be readily sub-dividable into different types, such as headings, legends, and bulk

25 text. Using existing techniques as indicated above, similarity searching will involve extraction of one element in a particular data type followed by similarity searching appropriate to that data type.

An example of such a sequential approach is found in US Patent No. 6,002,798. This provides for an initial structural analysis of a document into areas of different type: not simply into image plus text, but also into areas of different functional significance (eg title, heading, text block). This structural information is then used to allow user

5 searching and text indexing in chosen functional elements of the document. This mechanism is particularly useful for making the problem of text searching in complex documents more tractable - it is not, however, effective to allow searching for documents which are as a whole similar to a query document.

10 It is desirable to provide methods of similarity searching which allow the features of the document to be used appropriately in a search that is properly representative of the full document.

Summary of Invention

15 Accordingly, in a first aspect the invention provides method of searching a database to find documents similar to a query document, comprising: decomposing the query document into elements of different data types; for one or more of the elements in a first data type, conducting a first data type similarity search to return match results

20 from the database for the one or more elements in the first data type; for one or more of the elements in a second data type, conducting a second data type similarity search to return match results from the database for the one or more elements in the second data type; combining the match results from the first data type similarity search and the second data type similarity search to provide query document match results.

25 Advantageously, results from each query document match may be combined to allow progressive refinement of queries using any of the data types either singly or in further combination.

30 In a second aspect, the invention provides a method of searching a database to find documents similar to a query document, comprising: decomposing the query document into elements of different data types; determining a layout element in a layout datatype from the spatial arrangement of the elements in the document; for the

layout element, conducting a layout similarity search to return match results from the database for the layout element.

Brief Description of Figures

5

Specific embodiments of the invention are described below, by way of example, with reference to the accompanying drawings, of which:

Figure 1 shows a typical document page containing different data types;

10

Figure 2 shows steps in a method according to an embodiment of a first aspect of the invention for conducting a similarity search for the document shown in Figure 1;

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Figure 3 shows the representation of the document shown in Figure 1 as a layout of datatypes, and indicates a search step usable in a further embodiment of the method of the invention; and

Figure 4 shows steps in a method according to an embodiment of the second aspect of the invention for conducting a similarity search for layout information.

20

Description of Embodiments

25

A typical document contains a plurality of data types. The most basic data types are text and images. Document 1 shown in Figure 1 contains a text block 12 - this text block is data in a first data type. Document 1 also contains two different kinds of image. One kind, image block 13, is a photographic image, typically consisting of an array of pixels in which each pixel has a colour value. The other kind, line art block 11, is also an image but a "drawn" one, readily representable as a combination of geometric or formulaic elements - and as such, typically readily scalable.

30

Photographic images and line art images (hereafter "pictures" and "graphics") respond differently to different image processing and analysis techniques, and are most effectively treated as different data types. Moreover, pictures and graphics will generally serve a different purpose in a document, so it is also practical for the purpose of similarity searching to treat pictures and graphics separately.

The steps involved in similarity searching for the document of Figure 1 according to an embodiment of the first aspect of the invention are shown in Figure 2.

- 5 Firstly the document 1 is selected in step 21. For an electronic document, this could be achieved through any appropriate application capable of supporting the file type or file types of the document. For a physical document, this could be achieved by scanning the document using a scanner.
- 10 Secondly in step 22, the document is decomposed into separate elements: in the case of document 1, these elements are graphic block 11, text block 12, and picture block 13. In the case of text block 12, it is desirable for optical character recognition to be carried out at this point so that the text block element resulting from decomposition consists of ASCII text. Decomposition of the document is achieved by an analysis 15 and recognition process through which the different parts of the document are recognised as being text, pictures or graphics. Decomposition of a document into separate data types in this way is known, using for example techniques identified in "Block Segmentation and Text Extraction in Mixed Text/Image Documents" by FM Wahl, KY Wong and RG Casey, Computer Graphics and Image Processing, Vol. 20 20 (1982) (a further example is provided in US Patent No. 6,002,798). Software adapted for use with proprietary scanners to decompose the elements of a scanned page into separate data types (in order to optimise the scanning process for each data type) is provided by Hewlett-Packard Company as "HP PrecisionScan". The output of HP PrecisionScan is a set of elements each in a single data type, each of which can be 25 selected for further processing.

The result of decomposition is a set of elements, each element having a single data type. For a particular data type, such as text, then either all text is determined to be part of a single element, or else physically distinct areas of text are considered as 30 separate elements, depending on how the decomposition is carried out. In one version of the embodiment all the elements of the document are used in similarity searching: in other versions one or more of the elements are selected for use in similarity searching (or the user is even allowed an opportunity to select part of an element for such further processing).

Separate elements are then used in similarity searching 23, 24 against a database, for example a database representing content available on the World Wide Web. Should
5 all the elements be of one data type, this reduces to a conventional similarity searching problem addressable with a single search engine for the relevant data type. However, if elements are of different data types, then separate search engines are used for each data type. Appropriate search engines for similarity searching for different data types are known. For example, for text, appropriate linguistic matching toolkits
10 are available from Teragram Corporation (<http://www.teragram.com>) and Inxight Software, Inc. (<http://www.inxight.com/>). In each case an appropriate preconditioning step 23 is desirable before the matching step 24, as will be discussed briefly in relation to the main data types below.

15 For example, Inxight Summarizer is a software component technology that summarises a document by extracting key sentences from the document. This is the preconditioning step 23. These summaries can then be matched against each other in the matching step 24. Inxight Summarizer generates indicative summaries that contain key sentence elements from a document. The essence of the text is extracted by
20 stemming and text normalisation technology to obtain a concise and canonical synopsis of the text. "Stemming" is the replacement of a word by its root and part-of-speech (e.g. "I had wanted" -> "to want/first person/pluperfect"), whereas "normalisation" involves replacement of one of several forms with a "concept" (e.g. "2/3/99, Feb 2nd, 1999 and 2nd February" are all alternate forms of the same concept).
25 The matching step 24 can then be carried out on the stemmed and normalised results of the preconditioning step 23 with confidence that text content which is genuinely similar will be matched without adverse influence from unwanted syntax considerations.

30 An example of an image searching tool is the IBM QBIC package, as indicated above. QBIC is further described at <http://wwwqbic.almaden.ibm.com/>. This package is adapted to precondition the images by analysing for a number of different criteria, such as colour percentages, colour layout, and textures occurring in the images. These criteria are then used in combination in a matching step 24. There are many

other known applications of “searching a ‘new’ image for known objects, from robot vision (a robot searching for parts in a bin), through to traffic monitoring systems (automatic detection of car license plates) - the present matching problem is essentially the inverse of these known problems.

5

It can be appreciated also that a serial approach could be used effectively: for example, first using a “straight edge” histogram to enable differentiation between natural and artificial scenes; then using an “edge length” histogram (an shortage of long edges probably indicates a natural scene); testing for a large area of blue tone at 10 the top of the image (indicating an outdoor scene); and testing for significant elements of flesh tones”, indicating that there is an image containing representations of people - which can be followed by a face matching analysis to find the same faces. Clearly a combination of serial and parallel steps can be employed.

15

The result of the similarity searching is a set of series of matching scores for documents in the database, such a set existing for each element searched. Each of these search scores needs to be normalised 25 for combination 26 to achieve a combined search result 27. The normalisation step 25 is to ensure that a correct 20 balance is given to the results of the different searching steps 24. This can either be to weight each element of the document equally, to weight each element of the document according to its perceived importance in the document, or according to a user assessment of the relative importance of the different elements of the document.

25 A preferred solution may involve a mixture of automatic and manual weighting. A particularly effective approach is to use synopsis generation techniques on the textual part to produce a set of textual search criteria and also to present a set of possible criteria based on the non-textual parts. These criteria are then presented to the user for verification. Such a user based approach is easy to use (and it is also easy for a 30 user to tell when it is ineffective). For example, a user may be asked if he/she wanted to search for things that matched the textual synopses, or, for the image and drawing parts, whether he wanted “this person”, “scenes like this”, “pictures containing this object”... or “pages that look like this one”.

The combined result 27 is as for conventional similarity searching: a series of matching scores (generally expressed as percentages) listing documents in the database from best towards worst matches.

5 Generally, most effective user querying will be achieved where it is possible for the user to achieve successive refinement of the user query - using the results of one round of querying as a basis for constructing the next round of querying - so in practice the combined result 27 will frequently be fed back to a later selection step to allow effective iterative searching.

10

Further use can be made of information derived from page decomposition in similarity searching. In addition to the separate elements provided by page decomposition (graphic 11, text block 12, and picture 13), further information is provided in the arrangement of the different elements within the document. As is shown in Figure 3, a further output available from page decomposition is a data type plan 31 representing the document as a line art block, a text block, and an image block, arranged vertically in sequence - decomposition into layouts is discussed in US Patent No. 6,002,798. However, the present inventors have appreciated that this data type plan can itself be used as a layout data type. This allows yet another element - the layout data type element - to be used in searching 32 of a database (provided that layout information is available in or derivable from the database entries). The results of similarity searching for such a layout element can be combined with similarity searches for other elements exactly as described in Figure 2., with layout data type 31 emerging from the decomposition step 22 and then being used in a searching step 32 equivalent and parallel to searching steps 23 and 24 (followed by a normalisation step before combination in step 26 with results from other data types).

In an embodiment according to the second aspect of the invention, similarity searching is conducted using the layout data type alone. The steps to be followed are essentially as in conventional similarity searching - this is shown in Figure 4, with elements common to the first aspect of the invention given the same reference numbers as in Figure 2. Layout similarity searching, whether used on its own or as one of the elements in a combined search as described in the first aspect of the invention, is more powerful if a number of different data types are used for text and

for overall document type. Using a rule-based approach, different text blocks and whole documents, especially in the case of formal workflow documents, can be assigned particular functions with relatively high confidence. For example, it is well known that isolated text blocks at the top of a page and handwriting at the bottom are suggestive of a letter, and so different spatial regions of the document can be assigned to appropriate functional fields (address, letter text etc) - likewise, table and currency totals in a document can be identified as a discrete element, and their presence limits the document to another group (bill, quote or invoice). Layout searching can thus involve matching to templates representing different workflow document types (thus promoting matching of a document determined to be a letter against other letters). An appropriate mechanism is to normalise a layout for size, orientation and skew, and then carrying out an "exclusive or" operation on the query element and the layout records in the database - this will be effective provided that all records involved have a broadly common format.

The difficulty of this problem depends on the nature and type of documents that are to be considered for matching. If the "universe" of documents is well defined, then there are tools available that can do an accurate job of classifying and labelling within that universe (e.g. OfficeMaid from DFKI). What is required in this case is classification according to a set of conventions laid down for the various classes of documents available for consideration. Conventions are here essentially rules that need not be closely followed: consequently an appropriate approach to this problem is rule based (most conveniently using fuzzy rules). Training of a neural network would also be an effective approach to adopt. The skilled person will appreciate how conventional fuzzy rule or neural network approaches could be adapted for use in a solution to this problem.

The skilled man will appreciate that modifications of the embodiments described above can readily be carried out without departing from the invention as defined in the claims.

CLAIMS

1. A method of searching a database to find documents similar to a query
5 document, comprising:

decomposing the query document into elements of different data types;

10 for one or more of the elements in a first data type, conducting a first data type similarity search to return match results from the database for the one or more elements in the first data type;

15 for one or more of the elements in a second data type, conducting a second data type similarity search to return match results from the database for the one or more elements in the first data type;

combining the match results from the first data type similarity search and the second data type similarity search to provide query document match results.

20 2. A method as claimed in claim 1, wherein one of the data types is representative of text.

25 3. A method as claimed in claim 2, wherein a plurality of the data types are representative of text, separate data types of the plurality being representative of different functional blocks of text.

4. A method as claimed in any preceding claim, wherein one of the data types is representative of pictorial images.

30 5. A method as claimed in any preceding claim, wherein one of the data types is representative of graphical images.

6. A method as claimed in any preceding claim, wherein one of the data types is representative of the arrangement of other data types within the document.

7. A method as claimed in any preceding claim, wherein the step of similarity searching to return match results is carried out, separately, for a plurality of elements having between them more than two data types.

5 8. A method as claimed in any preceding claim, where all features of a common data type in the document are treated as one element.

9. A method as claimed in any of claims 1 to 7, where spatially distinct features of a common data type in the document are treated as separate elements.

10

10. A method as claimed in any preceding claim, wherein elements are user selectable or deselectable for the step of similarity searching.

11. A method as claimed in any preceding claim, wherein the similarity searching results for separate elements are weighted before combination.

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12. A method as claimed in claim 11, wherein said weighting is user selected.

13. A method as claimed in claim 11, wherein said weighting is attributed according to a determined significance of each relevant element in the document.

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14. A method of searching a database to find documents similar to a query document, comprising:

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decomposing the query document into elements of different data types;

determining a layout element in a layout datatype from the spatial arrangement of the elements in the document;

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for the layout element, conducting a layout similarity search to return match results from the database for the layout element.

15. A method as claimed in claim 14, wherein the layout similarity search involves searching against templates representative of different document types.
- 5 16. A method as claimed in claim 14, wherein the elements include elements of separate data types representative of different functional blocks of text.
17. A method as claimed in claim 14 or claim 16, wherein the elements include elements of data types representative of images.

ABSTRACT

Similarity Searching For Documents

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A method of searching a database, such as a database representative of content on the World Wide Web, to find documents similar to a query document, involves a step of decomposing 22 the query document 1 into elements of different data types. After this, for one or more of the elements in a first data type, a first data type similarity search is conducted 23 to return match results from the database for the one or more elements in the first data type. For one or more of the elements in a second data type, a second data type similarity search is conducted to return match results from the database for the one or more elements in the first data type. The match results from the different data types are combined with an appropriate weighting to provide query document match results. Data types can include text, picture and graphics, and also the layout of the overall document.

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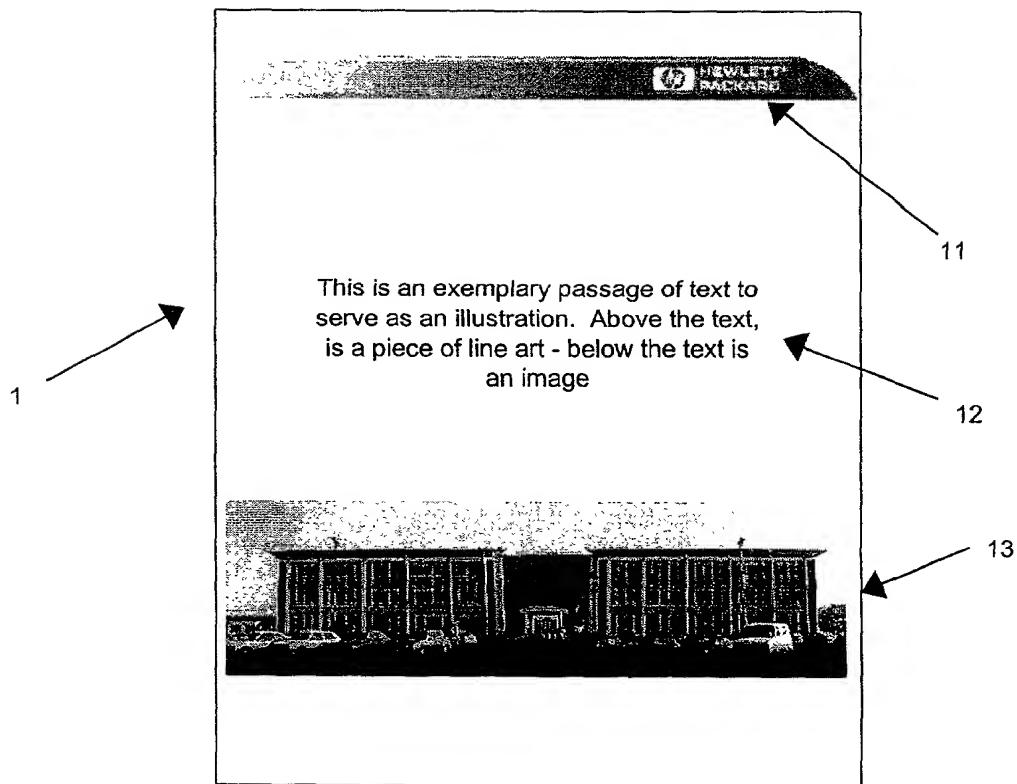


Figure 1

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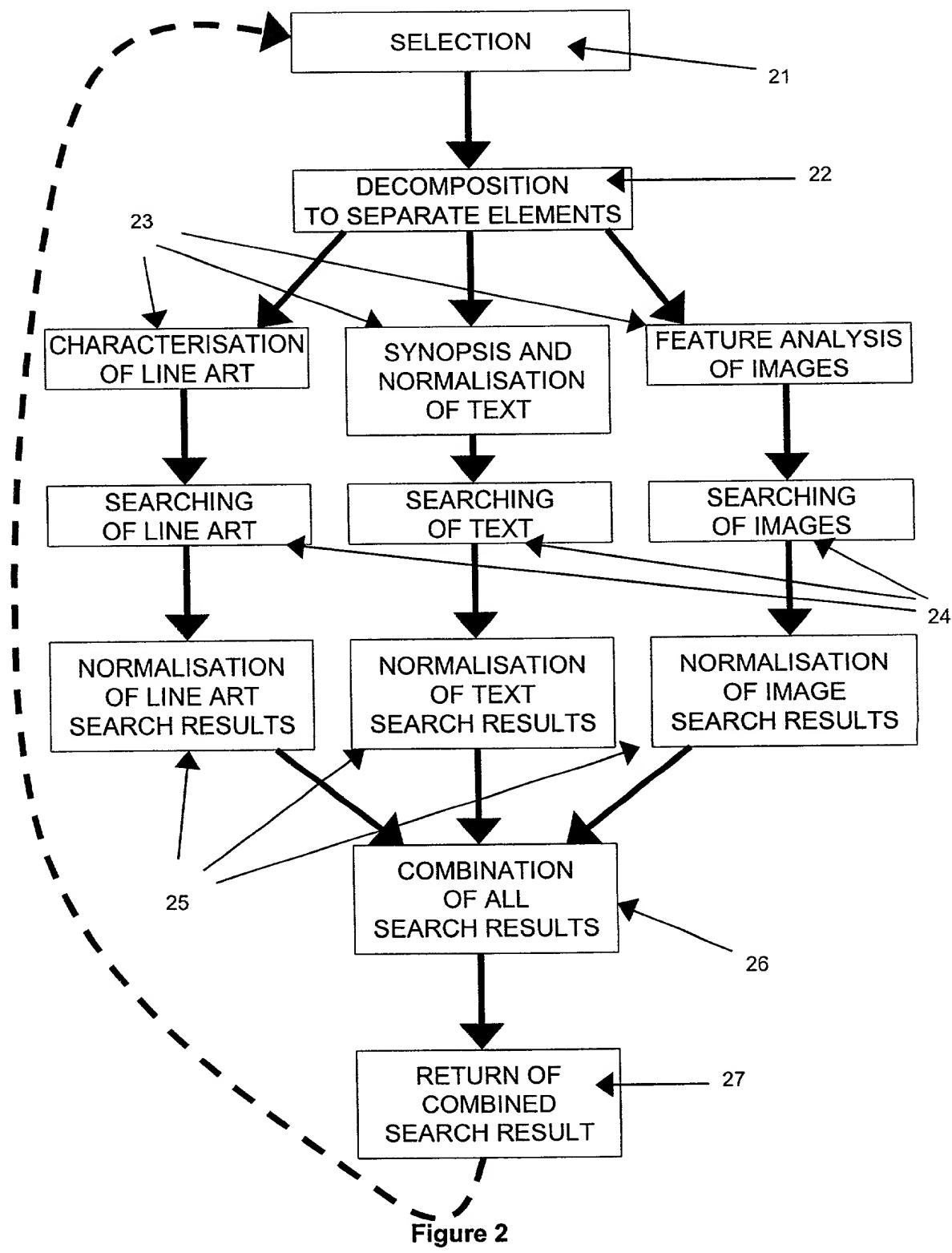


Figure 2

3/4

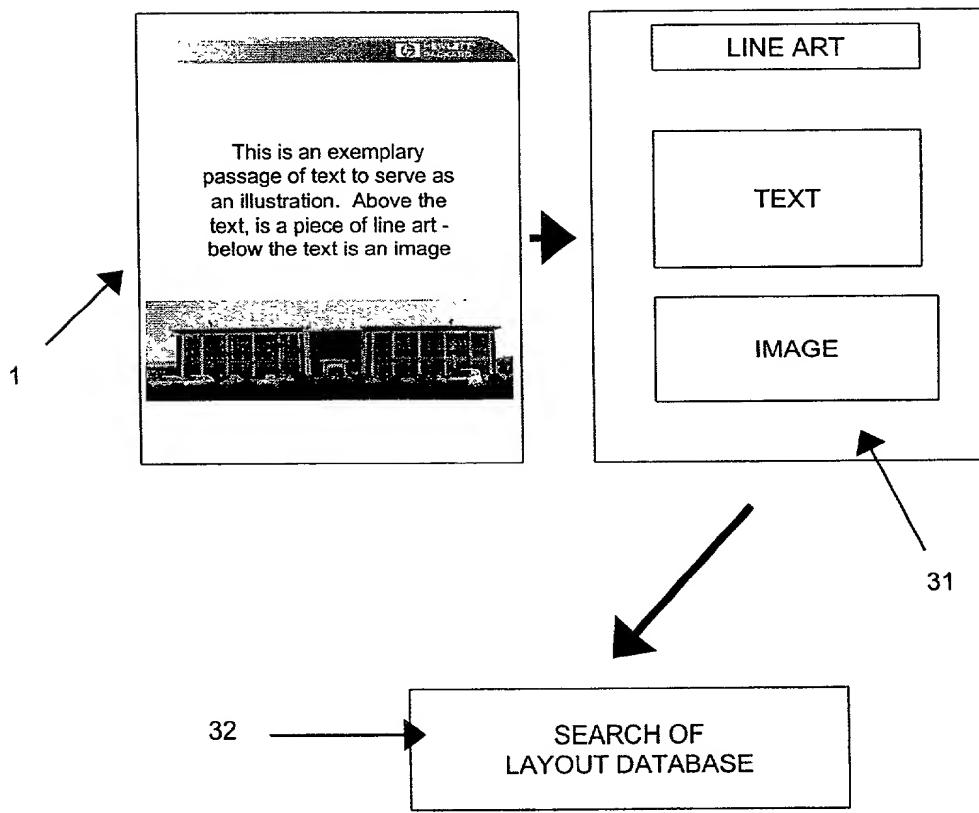


Figure 3

4/4

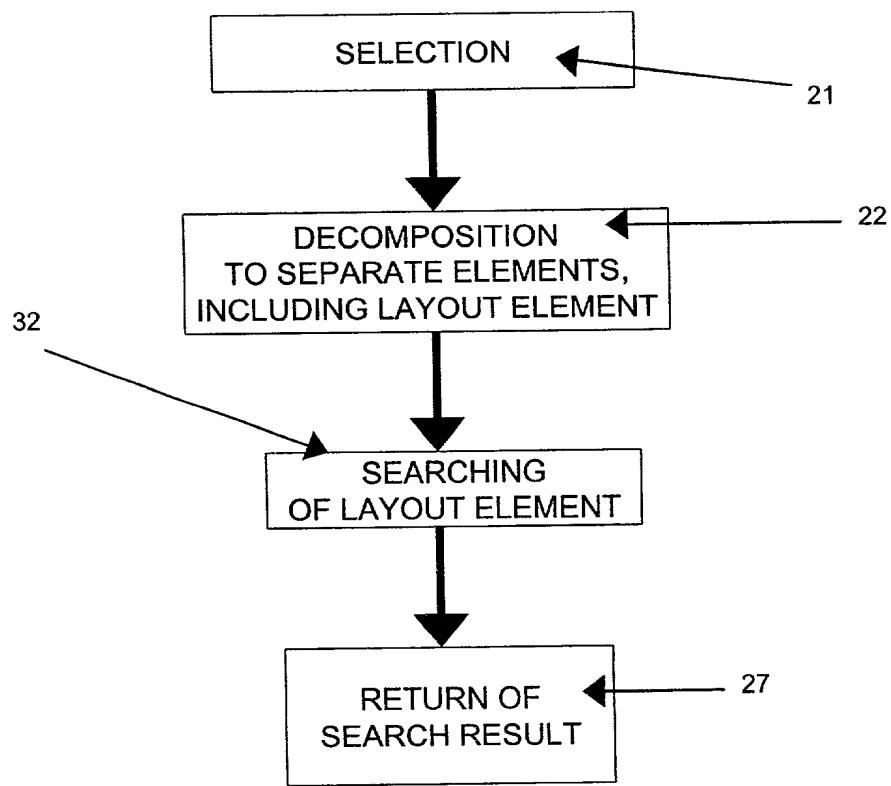
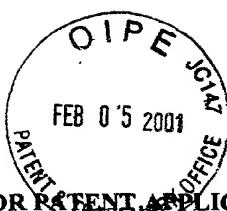


Figure 4



COMBINED DECLARATION FOR PATENT APPLICATION & POWER OF ATTORNEY ATTORNEY'S DOCKET No. 30990053
(Includes Reference to PCT International Applications)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Similarity Searching For Documents

the specification of which was filed as PCT international application

Number PCT/GB00/00489

on 15 February 2000

and was amended under PCT Article 19

on (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, '1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, '119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

| COUNTRY (if PCT indicate "PCT") | APPLICATION NUMBER | DATE OF FILING (day, month, year) | PRIORITY CLAIMED UNDER 35 USC 119 |
|------------------------------------|--------------------|--------------------------------------|---|
| GB | 9903451.4 | 16 February 1999 | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| | | | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| | | | <input type="checkbox"/> Yes <input type="checkbox"/> No |

I hereby claim the benefit under Title 35, United States Code, '120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, '112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, '1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:



COMBINED DECLARATION FOR PATENT APPLICATION & POWER OF ATTORNEY (Continued)
(Includes Reference to PCT International Applications)

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C.
120:

| U.S. APPLICATION NUMBER | U.S. FILING DATE | STATUS (Check one) |
|-------------------------|------------------|--------------------|
| | | PATENTED |
| | | PENDING |
| | | ABANDONED |

PCT APPLICATIONS DESIGNATING THE U.S.

| PCT APPLICATION NO. | PCT FILING DATE | U.S. SERIAL NUMBERS |
|---------------------|-----------------|---------------------|
| | | ASSIGNED (if any) |

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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